WE CLAIM:

1. An active air removal (AAR) system for purging air from an integrated extracorporeal blood circuit providing extracorporeal oxygenation of a patient's blood during cardiopulmonary bypass surgery adapted to be performed on a patient in the presence of a perfusionist, the AAR system comprising:

an air removal device incorporated in the extracorporeal blood circuit, the air removal device comprising:

an air removal device housing enclosing a chamber;

an air removal device purge port through the housing to the chamber; and

an air sensor supported by the air removal device housing in relation to the chamber adapted to provide an air sensor signal indicative of the presence of fluid or air in the air removal device housing;

an air removal device purge line coupled to the air removal device purge port and extending to a purge line connector adapted to be coupled to a vacuum source to apply suction to the air removal device purge port to draw air therefrom; and

an AAR controller having a purge valve adapted to receive a portion of the purge line and AAR controller circuitry to open or close the purge line, the AAR controller circuitry further comprising:

purge valve operating means for opening the purge valve in response to an air sensor signal indicative of the presence of air in the air removal device housing to allow air sensed in the air removal device to be purged through the purge line by the suction of the vacuum source;

error state determining means for monitoring operations and conditions of the AAR system and determining an error state of the AAR system; and

alerting means for alerting the perfusionist of the error state.

2. The AAR system of Claim 1, further wherein the AAR controller further comprises a mechanical release button interconnected with the purge valve adapted to enable manual opening of the purge valve by the perfusionist.

3. The AAR system of Claim 1, wherein:

the AAR controller further comprises a fluid in line (FIL) sensor arranged with respect to the purge valve adapted to receive a portion of the purge line to provide a FIL sensor signal to the AAR controller circuitry;

the error determining means determines if the FIL sensor signal indicates the presence of fluid in the purge line; and

the alerting means issues an alert that fluid is present in the purge line when the error determining means determines that the FIL sensor signal indicates the presence of fluid in the purge line.

4. The AAR system of Claim 3, wherein the purge valve operating means is inhibited from opening the purge valve in response the air sensor signal indicative of the presence of air in the air removal device housing when the FIL sensor signal is determined to be indicative of fluid in the purge line.

5. The AAR system of Claim 4, wherein the AAR controller further comprises a mechanical release button interconnected with the purge valve adapted to enable manual opening of the purge valve by the perfusionist when the purge valve is closed in response to the FIL sensor signal indicative of fluid in the purge line.

6. The AAR system of Claim 1, wherein:

the AAR controller further comprises a vacuum sensor arranged with respect to the purge line to provide a vacuum signal to the AAR controller circuitry indicative of vacuum in the purge line;

the error state determining means determines if the sensed vacuum exceeds a minimum vacuum; and

the alerting means issues an alert if the sensed vacuum does not exceed the minimum vacuum.

7. The AAR system of Claim 1, wherein:

the AAR controller has an air sensor cable connector;

an air removal device cable extends from the air sensor to a cable terminal coupled to the air sensor cable connector;

the error state determining means comprises an electrical continuity checking circuit of the AAR controller circuitry coupled to the air sensor cable connector that provides a continuity signal indicative of continuity of the connection of the air removal device cable between the air sensor and the air sensor cable connector; and

the alerting means issues an air removal device cable error alert if the continuity signal is not provided.

8. The AAR system of Claim 1, wherein:

the purge valve comprises a pinch valve having a valve slot receiving the portion of the purge line and a pinch rod adapted to be moved between a purge valve closed position extending into the slot to compress the purge line and a purge valve open position retracted out of the slot; and

the purge valve operating means is coupled to the pinch rod to move the pinch rod between the purge valve closed position and the purge valve open position.

9. The AAR system of Claim 8, wherein:

the error state determining means comprises:

at least one pinch rod position sensor providing a pinch rod position signal indicative of the actual position of the pinch rod; and

means responsive to the pinch rod position signal for determining a position error state of the purge valve or the purge valve operating means when the pinch rod position signal does not confirm that the pinch rod is in a purge valve open position or a purge valve closed position dictated by the purge valve operating means; and

the alerting means issues a pinch rod position error alert in responsive to the determined position error state.

10. The AAR system of Claim 1, wherein:

the error state determining means comprises:

at least one purge valve state sensor providing a purge state signal indicative of the actual open or closed state of the purge valve;

means responsive to the purge valve state signal for determining an error state of the purge valve or the purge valve operating means when the purge valve state signal does not confirm that the purge valve is in a commanded one of the purge valve open position and the purge valve closed position dictated by the purge valve operating means; and

the alerting means issues a purge valve error alert in responsive to the determined position error state.

11. The AAR system of Claim 1, wherein:

the AAR controller further comprises a power supply adapted to be coupled to electrical mains power for providing operating power to the AAR controller circuitry and purge valve operating means;

the error state determining means determines if the power supply is providing adequate operating power; and

the alerting means issues a power supply error alert if the power supply is not providing adequate operating power.

12. The AAR system of Claim 11, wherein the power supply comprises redundant power supply circuits and means for selecting an operable power supply circuit.

13. The AAR system of Claim 12, wherein:

the AAR controller further comprises a backup battery for providing operating power to the AAR controller circuitry;

the error state determining means determines if the backup battery is providing adequate operating power; and

the alerting means issues a backup battery error alert if the backup battery is not providing adequate operating power.

14. The AAR system of Claim 11, wherein:

the AAR controller further comprises a backup battery for providing operating power to the AAR controller circuitry; and

the AAR controller circuitry is powered by the backup battery when the error state determining means determines that the power supply is not providing adequate operating power.

15. The AAR system of Claim 14, wherein:

the purge valve operating means is disabled when the AAR controller circuitry is powered by the backup battery; and

the AAR controller further comprises a mechanical release button interconnected with the purge valve adapted to enable manual opening of the purge valve by the perfusionist.

16. The AAR system of Claim 14, wherein the alerting means issues a backup battery alert if the AAR controller circuitry is powered by the backup battery.

17. The AAR system of Claim 1, wherein:

the AAR controller further comprises a backup battery for providing operating power to the AAR controller circuitry;

the error state determining means determines if the backup battery is providing adequate operating power; and

the alerting means issues a backup battery error alert if the backup battery is not providing adequate operating power.

18. The AAR system of Claim 1, wherein:

the alerting means formulates alert message signals; and

the AAR controller further comprises a display screen that the alert messages are applied to for displaying messages readable by the perfusionist.

19. The AAR system of Claim 1, wherein:

the alerting means formulates alert sound signals; and

the AAR controller further comprises at least one sound emitter that emits audible alert sounds in response to the alert sound signals that can be heard by the perfusionist.

20. The AAR system of Claim 1, wherein:

the alerting means formulates alert light signals; and

the AAR controller further comprises at least one light emitter that emits visual light in response to the alert light signals that can be seen by the perfusionist.

21. A method of operating an active air removal (AAR) system to purge air from an integrated extracorporeal blood circuit providing extracorporeal oxygenation of a patient's blood during cardiopulmonary bypass surgery adapted to be performed in the presence of a perfusionist on a patient in an operating room, the method comprising:

providing an air removal device incorporated in the extracorporeal blood circuit, the air removal device comprising:

an air removal device housing enclosing a chamber;

an air removal device purge port through the housing to the chamber;

an air sensor supported by the air removal device housing; and

an air removal device purge line coupled to the air removal device purge port extending to a purge line connector adapted to be coupled to a vacuum source to apply suction to the air removal device purge port to draw air therefrom;

locating a portion of the air removal purge line extending through a purge valve of an AAR controller, the purge valve movable between a purge valve open position and a purge valve closed position;

applying operating power to the air sensor to generate an air sensor signal indicative of the absence or presence of air in the air removal device housing;

opening the purge valve in response to an air sensor signal indicative of the presence of air in the air removal device housing to allow air sensed in the air removal device to be purged through the purge line by the suction of the vacuum source;

monitoring operations or conditions of the AAR system;

determining an error state of the monitored operations or conditions of the AAR system; and

issuing an alert to alert the perfusionist of the error state.

22. The purging method of Claim 21, further wherein the AAR controller further comprises a mechanical release button interconnected with the purge valve adapted to enable manual opening of the purge valve by the perfusionist.

23. The purging method of Claim 21, wherein the AAR controller further comprises a fluid in line (FIL) sensor arranged with respect to the purge valve, and further comprising:

locating a further portion of the purge line through the FIL sensor; and

powering the FIL sensor to develop a FIL sensor signal indicative of the absence or presence of fluid in the purge line,

and wherein:

the error state determining step comprises determining if the FIL sensor signal indicates the presence of fluid in the purge line.

24. The purging method of Claim 23, further comprising inhibiting the opening of the purge valve when the FIL sensor signal is determined to be indicative of fluid in the purge line.

25. The purging method of Claim 24, wherein the AAR controller further comprises a mechanical release button interconnected with the purge valve adapted to enable manual opening of the purge valve by the perfusionist.

26. The purging method of Claim 21, wherein:

the AAR controller further comprises a vacuum sensor arranged with respect to the purge line to provide a vacuum signal indicative of vacuum in the purge line;

the error state determining step determines if the sensed vacuum exceeds a minimum vacuum; and

the alert issuing step issues an alert if the sensed vacuum does not exceed the minimum vacuum.

27. The purging method of Claim 21, further comprising:

connecting an air sensor cable between the AAR controller and the air sensor; and wherein:

the determining step determines if electrical continuity is present in the connection of the air sensor cable between the AAR controller and the air sensor; and

the alert issuing step issues an air removal device cable error alert if electrical continuity is not determined.

28. The purging method of Claim 21, wherein:

the purge valve comprises a pinch valve having a valve slot receiving the portion of the purge line and a pinch rod adapted to be moved between a purge valve closed position extending into the slot to compress the purge line and a purge valve open position retracted out of the slot; and

the purge valve opening step comprises moving the pinch rod from the purge valve closed position to the purge valve open position.

29. The purging method of Claim 28, wherein:

the error state determining step comprises:

commanding the pinch rod to move into one of the pinch valve open and closed positions;

sensing the pinch rod position and providing a pinch rod position signal indicative of the actual position of the pinch rod; and

determining a position error state of the purge valve when the pinch rod position signal does not confirm that the pinch rod is in the commanded purge valve open or purge valve closed position; and

the alert issuing step comprises issuing a pinch rod position error alert in response to the determined position error state.

30. The purging method of Claim 21, wherein:

the error state determining step comprises:

commanding the purge valve to move into one of the purge valve open and closed positions;

sensing the purge valve position and providing a purge valve position signal indicative of the actual position of the purge valve; and

determining a position error state of the purge valve or the purge valve operating means when the sensed purge valve position signal does not confirm that the purge valve is in the commanded purge valve open position or purge valve closed position; and

the alert issuing step comprises issuing a purge valve error alert in responsive to the determined position error state.

31. The purging method of Claim 21, wherein:

the AAR controller further comprises AAR controller circuitry and a power supply adapted to be coupled to electrical mains power for providing operating power to the AAR controller circuitry;

the determining step comprises determining if the power supply is providing adequate operating power; and

the alert issuing step comprises issuing a power supply error alert if the power supply is not providing adequate operating power.

32. The purging method of Claim 31, wherein the power supply comprises redundant power supply circuits, and further comprising:

selecting an operable power supply circuit to provide operating power to the AAR controller.

33. The purging method of Claim 31, wherein the AAR controller further comprises a backup battery for providing operating power to the AAR controller circuitry, and further comprising:

powering the AAR controller circuitry by power from the backup battery when the determining step determines that the power supply is not providing adequate operating power.

34. The purging method of Claim 31, wherein the alert issuing step comprises issuing a backup battery alert if the AAR controller circuitry is powered by the backup battery.

35. The purging method of Claim 34, further comprising:

inhibiting the step of opening the purge valve in response to an air sensor signal indicative of the presence of air in the air removal device housing when the AAR controller circuitry is powered by the backup battery; and wherein:

the AAR controller further comprises a mechanical release button interconnected with the purge valve adapted to enable manual opening of the purge valve by the perfusionist.

36. The purging method of Claim 21, wherein:

the AAR controller further comprises AAR controller circuitry and a backup battery for providing operating power to the AAR controller circuitry;

the determining step comprises determining if the backup battery is providing adequate operating power; and

the alert issuing step comprises issuing a backup battery error alert if the backup battery is not providing adequate operating power.

37. The purging method of Claim 21, wherein:

the AAR controller further comprises a backup battery for providing operating power to the AAR controller circuitry;

the determining step comprises determining if the backup battery is providing adequate operating power; and

the alert issuing step comprises issuing a backup battery error alert if the backup battery is not providing adequate operating power.

38. The purging method of Claim 21, wherein the alert issuing step comprises:

formulating alert message signals related to the determined error state; and

displaying alert messages readable by the perfusionist on a display screen.

39. The purging method of Claim 21, wherein the alert issuing step comprises:

formulating alert sound signals related to the determined error state; and

applying the formulated alert sound signals to a sound emitter that emits audible alert sounds that can be heard by the perfusionist.

40. The purging method of Claim 21, wherein the alert issuing step comprises:

formulating alert light signals related to the determined error state; and

applying the formulated alert light signals to at least one light emitter that emits visual light in response to the alert light signals that can be seen by the perfusionist.

41. A method of operating an active air removal (AAR) system to purge air from an integrated extracorporeal blood circuit providing extracorporeal oxygenation of a patient's blood during cardiopulmonary bypass surgery adapted to be performed in the presence of a perfusionist on a patient in an operating room, the operating method comprising:

providing an air removal device incorporated in the extracorporeal blood circuit, the air removal device comprising:

an air removal device housing enclosing a chamber;

an air removal device purge port through the housing to the chamber;

an air sensor supported by the air removal device housing adapted to provide an air sensor signal indicative of air in the air removal device housing;

an air removal device purge line coupled to the air removal device purge port and extending to a purge line connector adapted to be coupled to a vacuum source to apply suction to the air removal device purge port to draw air therefrom;

providing an active air removal AAR controller operating under the control of an AAR operating algorithm;

locating a portion of the air removal purge line extending through a purge valve of the AAR controller, the purge valve movable between a purge valve open position and a purge valve closed position;

coupling the air sensor with the AAR controller;

monitoring operations or conditions of the AAR system;

determining an error state of the monitored operations or conditions of the AAR system; and

automatically moving of the purge valve from the closed position to the open position in an absence of a determined error state and when the air sensor signal is indicative of air in the air removal device housing to allow air sensed in the air removal device to be purged through the purge line by the suction of the vacuum source.

42. The method of Claim 42, wherein the AAR controller operating system is powered by a power supply adapted to be coupled to mains power or by a backup battery, and further comprising:

determining if the power supply is operative and capable of supplying operating power to the AAR controller operating system;

determining if the backup battery is present and capable of supplying operating power to the AAR controller operating system; and

supplying operating power from the backup battery to the AAR controller operating system when the power supply is determined to be inoperative or incapable of supplying operating power to the AAR controller operating system and the backup battery is determined to be present and capable of supplying operating power to the AAR controller operating system.

43. The method of Claim 42, further comprising alerting the perfusionist of the determined power state.

44. The operating method of Claim 42, wherein the AAR controller further comprises a mechanical release button interconnected with the purge valve adapted to enable manual opening of the purge valve by the perfusionist.

45. The operating method of Claim 42, further comprising disabling the automatic movement of the purge valve from the closed position to the open position when the air sensor signal is indicative of air in the air removal device housing if the power supply is determined to be inoperative or incapable of supplying operating power to the AAR controller operating system.

46. The operating method of Claim 45, wherein the AAR controller further comprises a mechanical release button interconnected with the purge valve adapted to enable manual opening of the purge valve by the perfusionist.

47. The operating method of Claim 41, further comprising alerting the perfusionist of the determined error state.

48. The operating method of Claim 47, wherein the error state determining step comprises determining the presence of fluid in the purge line.

49. The operating method of Claim 41, wherein the AAR controller further comprises a fluid in line (FIL) sensor arranged with respect to the purge valve, and further comprising:

locating a further portion of the purge line through the FIL sensor; and

powering the FIL sensor to develop a FIL sensor signal indicative of the absence or presence of fluid in the purge line,

and wherein:

the error state determining step comprises determining the presence of fluid in the purge line from the FIL sensor signal.

50. The operating method of Claim 41, wherein the error state determining step comprises determining the presence of fluid in the purge line.

51. The operating method of Claim 50, wherein the AAR controller further comprises a mechanical release button interconnected with the purge valve adapted to enable manual opening of the purge valve by the perfusionist.

52. The operating method of Claim 41, further comprising:

connecting an air sensor cable between the AAR controller and the air sensor; and

wherein the determining step determines if electrical continuity is present in the connection of the air sensor cable between the AAR controller and the air sensor.

53. The operating method of Claim 41, wherein the error state determining step comprises determining an error state of the air sensor.

54. The operating method of Claim 41, wherein the error state determining step comprises determining a low vacuum condition.

55. The operating method of Claim 41, wherein:

the AAR controller further comprises a vacuum sensor arranged with respect to the purge line to provide a vacuum signal indicative of vacuum in the purge line;

the error state determining step determines a low vacuum error state if the sensed vacuum falls below a minimum vacuum.

56. The operating method of Claim 41, wherein the error state determining step comprises determining a purge valve error state of the purge valve.

57. The operating method of Claim 56, wherein the purge valve error state determining step comprises:

commanding the purge valve to move into one of the purge valve open and closed positions;

sensing the purge valve position and providing a purge valve position signal indicative of the actual position of the purge valve; and

determining a position error state of the purge valve or the purge valve operating means when the sensed purge valve position signal does not confirm that the purge valve is in the commanded purge valve open position or purge valve closed position.

58. The operating method of Claim 41, wherein:

the purge valve comprises a pinch valve having a valve slot receiving the portion of the purge line and a pinch rod adapted to be moved between a purge valve closed position extending into the slot to compress the purge line and a purge valve open position retracted out of the slot; and

the purge valve opening step comprises moving the pinch rod from the purge valve closed position to the purge valve open position.

59. The operating method of Claim 58, wherein the error state determining step comprises determining a pinch valve error state of the pinch valve.

60. The operating method of Claim 59, wherein the pinch valve error state determining step comprises:

commanding the pinch rod to move into one of the pinch valve open and closed positions;

sensing the pinch rod position and providing a pinch rod position signal indicative of the actual position of the pinch rod; and

determining a position error state of the purge valve when the pinch rod position signal does not confirm that the pinch rod is in the commanded pinch valve open or purge valve closed position.

61. The operating method of Claim 41, wherein:

the AAR controller further comprises a vacuum sensor arranged with respect to the purge line to provide a vacuum signal indicative of vacuum in the purge line when the purge valve is closed; and

the error state determining step comprises determining if the sensed vacuum exceeds a minimum vacuum.